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JEE MAIN (APRIL) 2023 (11-04-2023-FN)

Memory Based Question Paper

PHYSICS

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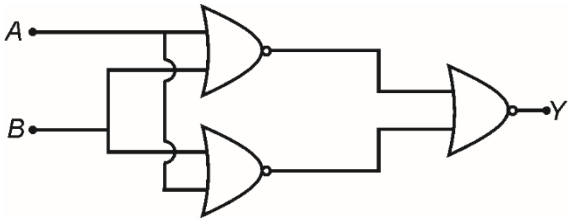
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Identify the logic operation of following circuit.



(1) AND (2) OR

(3) NOR (4) NAND

Answer (2)

Sol.

A	B	P	Q	Y	
1	0	0	0	1	
0	1	0	0	1	OR gate
1	1	0	0	1	
0	0	1	1	0	

2. Force acting on a particle moving along x-axis is given by $\vec{F} = (2+3x)\hat{i}$. The work done by this force from $x = 0$ to $x = 4$ m is

(1) 16 J (2) 32 J

(3) 4 J (4) 8 J

Answer (2)

Sol. $W = \int \vec{F} \cdot \overrightarrow{dr} = \int_0^4 (2+3x)\hat{i} \cdot dx\hat{i} = 2x + \frac{3}{2}x^2\Big|_0^4 = 32 \text{ J}$

3. If half life of a radioactive nuclide A is equal to average life of another radioactive nuclide B. Find the ratio of decay constant of A to that of B.

(1) ln2 : 1 (2) 1 : ln2

(3) 2 : ln2 (4) ln2 : 2

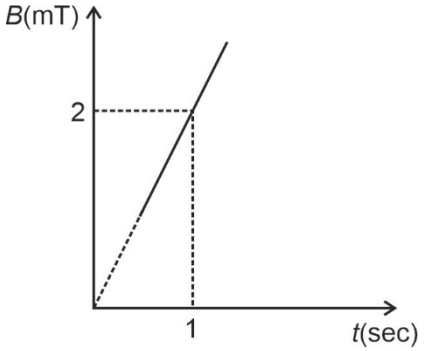
Answer (1)

Sol. $(t_{1/2})_A = (t_{mean})_B$

$$\frac{\ln(2)}{\lambda_A} = \frac{1}{\lambda_B}$$

$$\Rightarrow \frac{\lambda_A}{\lambda_B} = \ln 2$$

4. Variation of magnetic field through a coil of area 4 m^2 is shown in figure. What is the emf induced in the coil (in mV)?

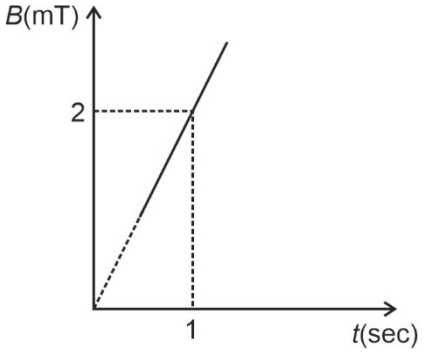


(1) 8 (2) 16

(3) 4 (4) 2

Answer (1)

Sol. From given figure, $\frac{dB}{dt} = 2$ mT/sec



$\because \quad \varepsilon_{ind} = \left|A\frac{dB}{dt}\right| = 4 \times 2 \text{ mV} = 8 \text{ mV}$

5. The characteristics of two coils is given below

	Coil-A	**Coil-B**
Radius	r_A = 10 cm	r_B = 20 cm
Number of turns	N_A	N_B
Current	I_A	I_B

If magnetic moment of both coil A and B are equal, then choose the correct relation

(1) $2N_AI_A = N_BI_B$

(2) $N_AI_A = N_BI_B$

(3) $N_AI_A = 4N_BI_B$

(4) $N_AI_A = 2N_BI_B$

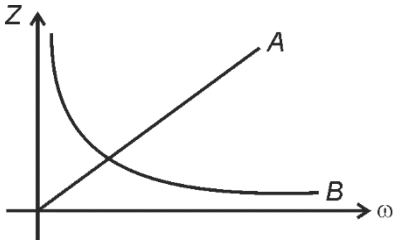
Answer (3)

Sol. $\mu = NIA \Rightarrow N_AI_Ar_A^2 = N_BI_Br_B^2$

$\Rightarrow N_AI_A = N_BI_B \times 4$

$N_AI_A = 4N_BI_B$

6. The variation of impedance (Z) with angular frequency (ω) for two electrical elements is shown in the graph given. If X_L, X_C and R are inductive reactance, capacitive reactance and resistance respectively, then



(1) A is resistor, B is inductor

(2) A is inductor, B is capacitor

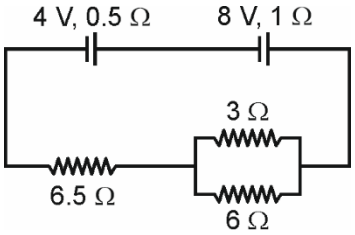
(3) A is inductor, B is resistor

(4) A is capacitor, B is inductor

Answer (2)

Sol. $X_L \propto \omega$, $X_C \propto \frac{1}{\omega}$, R is independent of ω

7. Find the current flowing in 3Ω resistor in the given circuit.



(1) 0.4 A (2) 0.2 A

(3) 0.8 A (4) 0.6 A

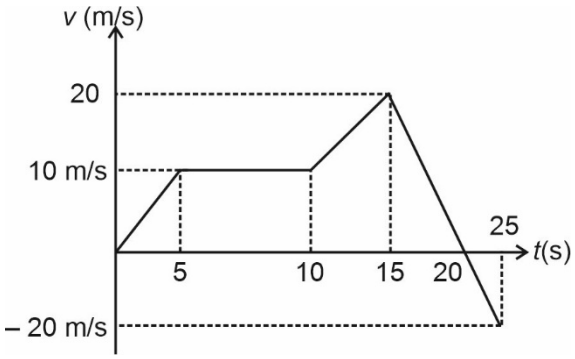
Answer (3)

Sol. ∵ Current (i) through equivalent battery

$= \frac{12}{10} = 1.2$ A

$\therefore \quad i_{3\Omega} = \frac{6}{9}\left(\frac{12}{10}\right) = 0.8$ A

8. Velocity of particle moving along a straight line is shown in figure. The distance and displacement travelled by the body is



(1) 150 m and 250 m (2) 250 m and 250 m

(3) 150 m and 150 m (4) 50 m and 150 m

Answer (1)

Sol. Displacement

$= \frac{1}{2}\times 10\times 5 + 5\times 10 + 50 + \frac{1}{2}\times 10\times 5 + 10\times 5 - 50$

$= 25 + 50 + 50 + 25$

$= 150$ m

Distance = 250 m

9. If light is passing through a medium of critical angle 45°, then the wave speed will be

(1) $\frac{3}{\sqrt{2}}\times 10^8$ m/s

(2) $3\sqrt{2}\times 10^8$ m/s

(3) $\frac{3}{2}\times 10^8$ m/s

(4) 3×10^8 m/s

Answer (1)

Sol. Refractive index of medium, $\mu = \frac{1}{\sin\theta_c} \Rightarrow \mu = \sqrt{2}$

$\therefore$ Light speed, $v = \frac{c}{\mu} = \frac{3}{\sqrt{2}}\times 10^8$ m/s

10. In moving coil galvanometer if number of turns increases by 25%, then change in voltage sensitivity is

(1) Zero

(2) 1%

(3) 25%

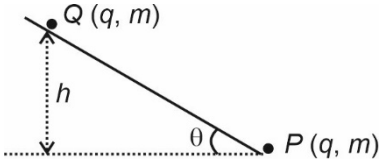
(4) 50%

Answer (1)

Sol. Voltage sensitivity = $\left(\frac{NAB}{KR}\right)\times\left(\frac{N}{R}\right)$

$\frac{N}{R}$ remains same.

11. A fixed charge P and another free charge Q having same mass and charge are shown in the diagram find the maximum height (h) attained by charge Q in equilibrium state on smooth inclined plane if $q = 2\mu C$, $\theta = 30°$, $m = 20$ g

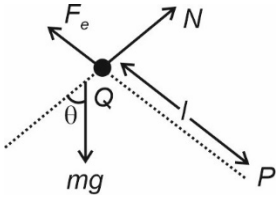


(1) 0.1 m (2) 0.3 m

(3) 0.4 m (4) 0.5 m

Answer (2)

Sol.



$\because F_e = mg\sin\theta$

$$\frac{Kq^2}{l^2} = mg\sin\theta$$

$$l = \sqrt{\frac{Kq^2}{mg\sin\theta}} = 0.6 \text{ m}$$

Also, $h = l\sin\theta = 0.3$ m

12. If a planet 'A' has density ρ and radius r, planet 'B' has density $\frac{\rho}{3}$ and radius $4r$. Then, find ratio of their acceleration due to gravity at their surface.

(1) 3 : 4 (2) 4 : 3

(3) 1 : 3 (4) 2 : 3

Answer (1)

Sol. $\because g \propto \rho R$

$$\therefore \frac{g_A}{g_A} = \frac{\rho r}{\frac{\rho}{3}\times 4r} = \frac{3}{4}$$

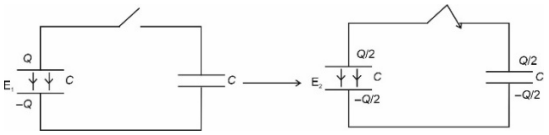
13. A 2 μF capacitor is charged with potential V and energy stored in capacitor is E_1. Now the capacitor is disconnected with battery and connected with another identical capacitor in parallel. Now the energy stored in capacitor is E_2. Find $\frac{E_1}{E_2}$

(1) 2 (2) 4

(3) 5 (4) 6

Answer (4)

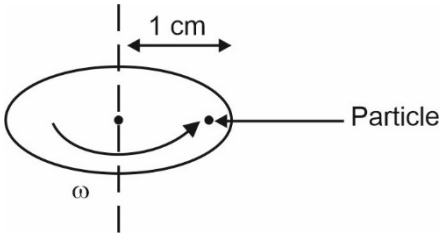
Sol.



$$E_1 = \frac{Q^2}{2C} \qquad E_2 = \frac{(Q/2)^2}{2C}$$

$$\therefore \frac{E_1}{E_2} = 4$$

14. A particle is kept at rest at 1 cm from axis on the disc rotating with angular velocity ω. If angular velocity is reduced to half of its initial value, then find the distance from axis, where particle again remains at rest



(1) 4 cm

(2) 6 cm

(3) 8 cm

(4) 12 cm

Answer (1)

Sol. $\mu mg = m\omega^2 x_1$

$$\mu mg = m\frac{\omega^2}{4}x_2$$

$$\Rightarrow \frac{4x_1}{x_2} = 1$$

$\Rightarrow x_2 = 4x_1$

$\Rightarrow x_2 = 4$ cm

15. Stopping potential for a metal when illuminated with light of wavelength λ is V_0 and that for wavelength 2λ is $\frac{V_0}{4}$. The threshold wavelength of metal is

(1) λ

(2) 2λ

(3) 3λ

(4) 4λ

Answer (3)

Sol. $eV_0 = \frac{hc}{\lambda} - \phi \quad ...(1)$

$\frac{eV_0}{4} = \frac{hc}{2\lambda} - \phi \quad ...(2)$

$\Rightarrow \frac{hc}{4\lambda} - \frac{\phi}{4} = \frac{hc}{2\lambda} - \phi$

$\phi - \frac{\phi}{4} = \frac{hc}{2\lambda} - \frac{hc}{4\lambda}$

$\frac{3\phi}{4} = \frac{hc}{4\lambda} \Rightarrow \phi = \left(\frac{hc}{3\lambda}\right)$

16. The correct order of root mean square speed (v_{rms}) for Ne, Cl_2 and OF_6 at same temperature is

(1) $(v_{rms})_{Ne} < (v_{rms})_{Cl_2} < (v_{rms})_{OF_6}$

(2) $(v_{rms})_{Cl_2} < (v_{rms})_{Ne} < (v_{rms})_{OF_6}$

(3) $(v_{rms})_{OF_6} < (v_{rms})_{Cl_2} < (v_{rms})_{Ne}$

(4) $(v_{rms})_{OF_6} < (v_{rms})_{Ne} < (v_{rms})_{Cl_2}$

Answer (3)

Sol. $\because \ v_{rms} \propto \frac{1}{\sqrt{M}}$

also, $M_{OF_6} > M_{Cl_2} > M_{Ne}$

$\because \ (v_{rms})_{OF_6} < (v_{rms})_{Cl_2} < (v_{rms})_{Ne}$

17. Two identical bulbs are first connected in series then in parallel. Find the ratio of power consumed in two cases.

(1) 1 : 1 (2) 1 : 4

(3) 4 : 1 (4) 1 : 2

Answer (2)

Sol. $P_1 = \frac{v^2}{2R} : P_2 = \frac{v^2}{\left(\frac{R}{2}\right)} = \frac{2v^2}{R}$

$\frac{P_1}{P_2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

18. **Statement-I:** Light year, parsec and AU are units for measuring distance.

Statement-II: (1 light year) > (1 parsec) > 1 AU

(1) Both statements I and II are correct

(2) Statement I is correct, statement II is incorrect

(3) Both statements I and II are incorrect

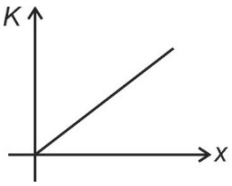
(4) Statement I is incorrect, statement II is correct

Answer (2)

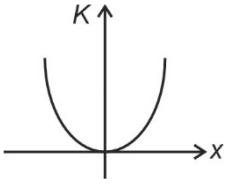
Sol. 1 parsec > 1 light year > 1 AU

19. For a particle undergoing linear SHM, the graph showing the variation of kinetic energy (K) with position (x) of particle is

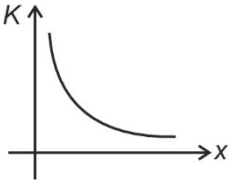
(1)



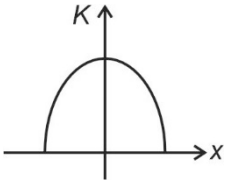
(2)



(3)



(4)



Answer (4)

Sol. $K = \frac{1}{2} m\omega^2 (A^2 - x^2)$

K vs x will be a parabola.

20. A scale read melting point of ice –15°X and boiling point 65°X. The, find 95°X temperature in fahrenheit.

(1) 428 F

(2) 280 F

(3) 350 F

(4) 210 F

Answer (2)

Sol. $\Rightarrow \ \frac{95 - (-15)}{F - 32} = \frac{65 - (-15)}{180}$

$\Rightarrow \ F = \frac{110 \times 180}{80} + 32 = 279.5$

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. Equation of progressive wave is

$y = A\sin(160t - 0.5x)$.

Let the speed of wave is $10x$, find x.

Answer (32)

Sol. From given equation,

$\omega = 160$ and $k = 0.5$

$\therefore$ Speed of wave,

$$v = \frac{\omega}{k} = \frac{160}{0.5} = 320 \text{ m/s}$$

22. A machine gun is firing 10 g bullets with speed 250 m/s. To keep machine gun in position 125 N force is required. Find no. of bullets fired per second.

Answer (50)

Sol. $$F = n_{1\,\text{sec}} \cdot mv \Rightarrow n_{1\,\text{sec}} = \frac{125}{10 \times 10^{-3} \times 250} = 50$$

23. A particle is projected at an angle of 30º with horizontal. Height of particle at 3 s and 5 s are same. Find the speed of projection in m/s. (g = 10 m/s^2)

Answer (80)

Sol. $T = 8$ sec

$$\frac{T}{2} = 4\,\text{sec}$$

$$\frac{u\sin\theta}{g} = 4$$

$$u = \frac{40}{\sin 30} = 80 \text{ m/s}$$

24. An antenna is required for LOS communication upto a distance of 4 km. The height (in m) of the antenna is (Radius of earth is 6400 km)

Answer (01.25)

Sol. $d = \sqrt{2Rh}$

$$4 = \sqrt{2 \times 6400 \times h}$$

$h = 1.25$ m

25. A material is placed in a toroid. Find the percentage change in magnetic field of toroid if susceptibility of material is $\chi = 2 \times 10^{-2}$

Answer (2)

Sol. $$\frac{\Delta B}{B_0} = (\chi)$$

$$\frac{\Delta B}{B_0} \times 100 = 100\,\chi$$

$= 2 \times 10^{-2} \times 100 = 2\%$

26.

27.

28.

29.

30.